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DEW LINE NARRATIVE REFRACTIVE INDEX CLIMATOLOGIES,(U)

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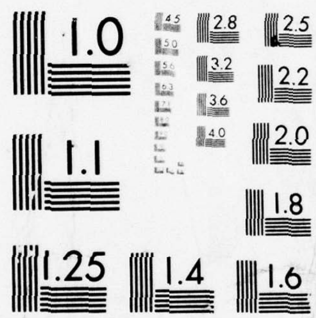
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USAF ENVIRONMENTAL TECHNICAL APPLICATIONS CENTER

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Report 8056

DEW LINE NARRATIVE REFRACTIVE INDEX CLIMATOLOGIES

by

James E. Warnke, SSgt, USAF
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November 1976

Approved for public release; distribution unlimited.

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The categories of normal and abnormal propagation conditions are used to describe the propagation conditions for each season at 13 locations in Alaska, Canada, and Greenland. Meteorological factors that influence the climate are related to the resulting propagation climatologies.

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Item 19 (Continued)

Galena, Alaska
Cold Bay, Alaska
Adak, Alaska
Pt. Barrow, Alaska
Barter Island, Alaska
Argentia, Canada
Melville, Canada
Cape Parry, Canada
Cambridge Bay, Canada
Hall Beach, Canada
Cape Dyer, Canada
Thule, Greenland
Dye-3, Greenland

PREFACE

USAFETAC prepared this report in answer to a request from Air Force Communications Service (AFCS) for annual refractive propagation climatology summaries for thirteen selected Dew Line Sites.

The purpose of this study is to provide an understanding of the correlation between local climatology and potential refractivity effects on flight facilities equipment.

If this report is incorporated into another report by the requester or any other agency, request that USAFETAC be furnished a copy of the new report in all cases where such dissemination is not prohibited.

USAFETAC prepared this report to provide information for a specific application. No further application is intended. Department of Defense (DoD) agencies and DoD contractors should refer any questions on this study or on related problems to USAFETAC for consultation and study.

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DEW LINE NARRATIVE REFRACTIVE INDEX CLIMATOLOGIES

Introduction

The Traffic Control and Landing System (TRACALS) evaluation program conducted by Air Force Communications Service (AFCS) requires a narrative summary of annual refractive propagation climatology for each base being evaluated. These summaries are intended to provide an understanding of the correlation between local weather conditions and potential refractivity effects and are published in the final TRACALS evaluation report. USAFETAC prepared this report to provide such information for thirteen selected Dew Line locations.

Discussion

The general climatic patterns were evaluated for each location using regional climatological data summaries and studies. Parameters such as predominant pressure systems, air mass regime, and regional wind flow were determined. Next, local effects were analyzed using the Revised Uniform Summary of Surface Weather Observations (RUSSWO) Terminal Forecast Reference Files (TFRF) and other local forecast/climatology studies. Items such as proximity to water and mountains, general geographical location and orographic features were considered with emphasis on local modifying phenomena, (i.e., land/sea breeze, precipitation, diurnal variation). Once analysis of this information was completed, USAFETAC Refractive Index (RI) listings and summaries were reviewed for each station. A comparison of the occurrence of refractive gradients during each month with the prevailing climatic conditions was completed. A

seasonal breakdown was determined for each location with the results of this comparison as the basis. In the case of all locations in this report, modified temperate zone seasons of winter, spring, summer and fall were used. In all cases, the migration of the sun and the resultant amount of incoming solar radiation (insolation) were the primary climatic controls.

Analysis of the R.I. listings and summaries was completed and comparisons made to attempt to define causes for occurrences of specific refractive categories at designated height levels. This analysis revealed that an elevated subsidence inversion and a surface-based radiation inversion were the cause of many of the abnormal refractive conditions at these locations. The terms normal and abnormal refractive conditions used in this report refer to those refractive categories of subrefractive, normal, superrefractive, and trapping as defined by Davis and Wagner in USAFETAC Technical Note 73-4, April 1973. [4]

Refractive Index listings and summaries were available for all locations except Melville, Cape Parry, and Cape Dyer, Canada and Dye-3, Greenland. Goose Bay data was used for Melville and Sachs Harbour for Cape Parry since these locations are in close proximity to the requested sites. The analysis takes into consideration geographical and topographical differences. Cape Dyer, Canada and Dye-3, Greenland had no upper-air stations in the area which would be representative of their own conditions. As stated in these individual summaries, the evaluations of refractive conditions at these locations are based on applied known climatology and accepted refractivity theories only.

PROPAGATION CLIMATOLOGY
FOR
GALENA, ALASKA

Prepared by

USAFETAC

Galena, Alaska is located on the north bank of the Yukon River approximately midway between Fairbanks and Nome. The terrain in the immediate vicinity is relatively flat with distant mountains in virtually all directions.

The climate at Galena is primarily determined by the amount of insolation received from the sun. The summer and winter seasons are very long, while spring and autumn are short transition periods. Refractive propagation conditions change very slightly with the seasons and remain relatively good throughout the year. No refractive index information is available for Galena; therefore, this narrative uses summary data from Nome, Fairbanks, and McGrath as a basis for conditions at Galena.

WINTER

During the winter, the dominant air mass in the Galena area is Polar continental. The sun has migrated south such that Alaska receives very little solar insolation. Due to this lack of insolation, the snow and ice-covered ground radiates heat almost constantly, causing temperatures at the surface and just above to be extremely cold. These cold surface temperatures with warmer temperatures aloft cause the formation of a very strong radiation inversion. This phenomenon can result in

abnormal refractive conditions depending on the moisture gradient through the inversion. Most of the surface-based trapping, superrefractive, and subrefractive layers are caused by this inversion although its existence does not in itself always indicate abnormal refractive conditions.

Another cause of abnormal refractive conditions during the winter is the existence of an elevated subsidence inversion. This inversion, caused primarily by the intense Siberian high, has a strong temperature and moisture gradient. This gradient usually results in the presence of a superrefractive or trapping layer starting at the base of the inversion. Although this phenomenon exists aperiodically throughout the winter it usually is weak enough that normal refractive conditions prevail through the inversion.

SUMMER

The summer months at Galena are marked by almost constant solar insolation as the sun remains above the horizon the majority of the time. This insolation results in the land areas becoming much warmer than the surrounding water which causes the formation of thermal lows over the exterior of Alaska. These lows induce the flow of cool Arctic maritime air into the interior. This air is moist and turbulent in the lower levels and dry aloft. At the level where the atmosphere changes from moist to dry, a subsidence type inversion forms. If the moisture gradient is strong enough through this inversion, a superrefractive or trapping layer will exist. This condition is the primary cause of the abnormal refractive conditions in the Galena area during the summer season.

SPRING AND AUTUMN

The transition seasons between winter and summer are extremely short as the sun migrates north or south. It is during these periods that refractive conditions are most nearly normal as the prime causes of abnormal conditions within each season are either intensifying or subsiding.

It should be noted that although the causes of abnormal refractive conditions have been presented herein, normal conditions prevail throughout the year in the Galena area. The frequency of occurrence of subrefractive, superrefractive, and trapping layers is quite low as climatic controls do not often result in those atmospheric conditions which are radical enough to cause these phenomena.

PROPAGATION CLIMATOLOGY
FOR
COLD BAY, ALASKA

Prepared by

USAFETAC

The station at Cold Bay is located approximately 30 miles from the end of the Alaskan Peninsula, on the north west side of the bay from which the station derives its name. Across the bay, to the east, several mountains rise to elevations of approximately 5000 feet. Ten miles southwest of the station, Frosty Peak rises to an elevation of 5820 feet. The higher mountainous terrain southwest and east of the station blocks winds and precipitation approaching Cold Bay from these directions. The open area to the south-southeast of the station acts as a funnel for south-southeasterly winds. From the northeast to the west-northwest, the land is relatively flat with many small lakes and some swamp areas. There is little terrain influence on winds from these northerly directions.

Extensive nearby bodies of water exert a strong maritime influence on Cold Bay's climate and modify the seasons. During the winter months, air overlying the frozen surface of the Bering Sea can take on continental characteristics and bring cold and dry air to the Cold Bay area. The warmer periods of the year (late spring through early autumn) are dominated by maritime polar air masses. Due to the proximity of Cold Bay to the Alaskan mainland, spring does not begin until April and

extends into parts of June. August may be considered as the midsummer month while late September, October, and early November generally comprise the autumn months. Winter begins in late November and lasts through mid to late March.

WINTER

During the winter months normal refractive conditions prevail. Of the winter months, February is the best month to obtain normal refractive conditions. During these winter months, especially during February, Cold Bay is dominated by cold, dry continental polar air migrating southward over the frozen Bering Sea. This type of air mass generally causes refractive conditions which fall within the normal category. A shallow subrefractive layer may occur close to the surface due to a surface-based inversion. During the earlier winter months, superrefractivity or trapping may occur approximately within the first 2000 meters above the surface if an inversion is present. This inversion prevents humid air close to the surface from penetrating upward into the atmosphere. Consequently, atmospheric moisture content decreases rapidly within the inversion layer and abnormal refractive conditions may ensue. In mose cases this layer is thin and distinct. These conditions, caused by the elevated inversion, are most likely to occur when the wind is from a south or southeasterly direction. Overall, however, winter is the season to expect refractive conditions which fall within the normal category.

SUMMER

The months of July, August, and early September

comprise the summer season at Cold Bay. Cold Bay's summer climate is dominated by maritime influences. The prevailing southerly wind brings cool, moist air from the Gulf of Alaska to Cold Bay. The influx of cool, moist air in the lower layers of the atmosphere causes a maritime inversion to form. This inversion can move upward due to thermal convection occurring over the land. A superrefractive or trapping layer may accompany this fairly low-level inversion. The above phenomena coupled with diurnal effects and land/sea breeze effects make summer (the month of August in particular) the poorest time of the year to obtain normal refractive conditions.

SPRING AND AUTUMN

The spring and autumn seasons at Cold Bay are transition periods for refractive conditions and for climatic parameters. During the short autumn season, a gradual increase is observed in the number of times refractive conditions fall within the normal category. With the coming of spring, the frequency of occurrence of abnormal refractive conditions increase. These transition periods are the result of changing air mass types with their associated temperature and moisture characteristics.

PROPAGATION CLIMATOLOGY
FOR
ADAK ISLAND

Prepared by
USAFETAC

Adak Island is located near the center of the Andrean Group of the Aleutian Chain. The island itself is composed of rugged mountainous terrain. Adak Field is surrounded by mountains with the exception of two passes that lead away from the Field. One pass extends due west of Shagak Bay, while the second pass lies to the north of the field and extends between Mt. Moffett and Cape Adagak to Andrew Lagoon. The airfield is located on the lee side of Mr. Moffett (elevation 3900 feet).

Adak Island's climate is determined by several factors. The Aleutian low dominates the island's winter climate. During the summer season the effects of the Aleutian low are replaced by those of the Pacific high as it moves northward. Although Adak Island is located on the northern side of the Pacific high, some subsidence due to the presence of the high pressure system is observed. The waters surrounding Adak Island are warmed by an extension of the Kuroshio current which flows south of the Aleution Chain. These warm surrounding waters provide Adak Island with a constant low-level moisture source.

WINTER

Refractive conditions are within the normal category during the winter months. The Aleutian low is strongest

during this period. The warm waters encircling Adak Island provide added moisture to the convectively unstable lower layers of the maritime polar air mass, while the air aloft is generally cold and dry. Anomalous refractive conditions may be caused by a surface-based radiation inversion. When this occurs, subrefractive, superrefractive, or trapping conditions can occur near the surface. Anomalous refractive conditions can also occur above the maritime polar "moist" layer when the air dries rapidly within a fairly thin layer. This may occur due to a subsidence inversion aloft. Under these conditions, trapping or superrefractivity may be found within the thin layer. Winter, however, remains the season when normal refractive conditions occur most frequently.

SUMMER

During the summer season the refractive conditions progressively deteriorate from June through August. The air mass above Adak Island comes under the domination of the Pacific high and an elevated subsidence inversion can form. This elevated temperature inversion combined with a pronounced moisture decrease within the inversion layer may produce refractive conditions which fall into the superrefractive or trapping categories. This subsidence inversion may become more pronounced because of the fact that Adak Field is located on the lee side of Moffett and thus experiences some subsidence and warming of air due to downslope winds. The above factors, combined with summer land/sea breeze effects and diurnal effects, increase the probability of occurrence of abnormal refractive conditions during the summer months. These phenomena make summer the worst season of the year for normal refractive conditions.

SPRING AND AUTUMN

The spring and autumn seasons at Adak Island are transitional, both in terms of climatic parameters and in terms of refractive conditions. The autumn season shows an increase in normal refractive conditions through November. Spring shows a gradual deterioration in refractive conditions from March through May. These transition periods are the result of changes in the dominant pressure systems and associated air masses.

PROPAGATION CLIMATOLOGY
FOR
POINT BARROW, ALASKA

Prepared by

USAFETAC

Point Barrow is located on the extreme northern coast of the Alaskan peninsula. The Arctic Ocean extends to the north, east, and west of Barrow and has a pronounced effect on both the climate and refractive propagation conditions. Level tundra stretches approximately 200 miles south, leaving Barrow with no natural weather or wind barriers.

The climate at Barrow is controlled primarily by the amount of insolation received from the sun. The summer and winter seasons are relatively long, and the spring and autumn seasons are very short transition seasons. The refractive propagation conditions vary slightly with the seasons. Normal refractive propagation conditions prevail throughout the year with superrefractive and trapping layers occurring more frequently in the midsummer months. The winter season experiences a salient amount of abnormal conditions and the transitional periods enjoy the most normal refractive propagation conditions of the year.

WINTER

The winter season at Point Barrow is marked by the absence of insolation because the sun has migrated south

and remains below the horizon much of the time. This reduction in insolation results in an increase in radiation from the surface. The surface becomes increasingly colder than the air aloft which causes the formation of a radiation type inversion. This inversion is generally very thick; however, due to the warming influence of the water bodies in the area, the temperature gradient through the inversion is not as strong as over the continental portion of Alaska. It is this inversion that causes most of the abnormal refractive conditions at Barrow. However, the existence of this inversion does not in itself indicate the presence of abnormal refractive conditions. The strength of the inversion, that is, the temperature, and more importantly, the moisture gradients through the inversion, causes the abnormal conditions. Generally, the surface is dry relative to layers aloft due to the frozen conditions of the land and water. As the moisture content of the atmosphere increases with height a subrefractive stratum forms. This layer can be just above the surface or as high as 2000 meters. A reversal of the moisture gradient above this layer will often result in superrefractive or trapping conditions.

SUMMER

During the summer season, the sun has migrated north again and is above the horizon the majority of the time. This results in almost constant insolation and very little surface radiation; the complete opposite of conditions during the winter. The radiation inversion has broken down such that its existence is aperiodic. The primary cause of abnormal refractive conditions during this period is the existence of an elevated subsidence type inversion. Causes of this inversion are two-fold, the effect of the Arctic Ocean and the position of the Polar high pressure

system. The proximity of the Arctic Ocean to Point Barrow has the obvious effect of adding moisture to the lower layers of the atmosphere. The Polar high pressure system has moved north and weakened; however, during the summer it has its greatest effect on the Barrow area. Typical of the southeast side of any major high is subsiding warm dry air, and thus the formation of the subsidence type inversion. The increased moisture in the lower levels tends to strengthen the moisture gradient through this inversion and results in the existence of superrefractive and trapping layers whose bases coincide with that of the inversion.

SPRING AND AUTUMN

The transition seasons are relatively short as the sun migrates north and south quite rapidly. During these periods the primary causes of abnormal conditions during the summer and winter seasons are in the process of intensifying or diminishing, and thus have a lesser effect.

The primary causes of abnormal refractive conditions have been presented in this narrative; however, these are not the only causes. Because of the interaction of continental and maritime air masses, the existence and position of the Polar front and the effect of terrain and local influences, the atmosphere in the Alaskan area can be very radical and erratic. Temporary temperature and moisture distributions can and do result in the formation of subrefractive, superrefractive, and trapping layers.

PROPAGATION CLIMATOLOGY

FOR

BARTER ISLAND, ALASKA

Prepared by

USAFETAC

Barter Island, Alaska is located just off the north shore of the Alaskan mainland. The Beaufort Sea and the Artic Ocean surround Barter. The island terrain and the mainland south of Barter Island is low, flat, and generally marshy tundra with no elevations of consequence until the Brooks range 65 miles south. Therefore, there are no topographic climatic controls in the Barter Island area.

The climate at Barter is determined by the extent and duration of insolation. As at most northern stations, the summer and winter seasons are very long with the spring and autumn seasons being short transitional periods. The refractive propagation conditions vary with the seasonal changes. Normal conditions prevail during the transition seasons with degrees of deterioration during winter and summer, respectively. The Arctic Ocean has direct influence on both the climate and the refractivity conditions at Barter Island.

WINTER

The winter months at Barter Island are marked by a reduction in insolation as the sun has migrated south and remains below the horizon much of the time. The result is an increase in surface radiation and thus the lowering of temperatures at and near the surface. The land and water surfaces are frozen and snow covered with little

available moisture being carried into the lower layers. The elevated layers are relatively warm and moist, compared with the surface, which results in the formation of a thick radiation inversion. Although this inversion is persistent throughout the winter, and most of the trapping, superrefractive, and subrefractive layers exist due to the inversion's presence, its existence does not in inself indicate abnormal propagation conditions. Several factors modify the effect of this inversion on propagation conditions. The presence of the Arctic Ocean, although frozen, prevents the surface temperatures from becoming extremely cold, which would intensify the inversion. The winds during the winter months are relatively strong which has the effect of mixing the moisture that is available. This fact reduces the strength of the moisture gradient through the inversion.

SUMMER

Abnormal propagation conditions occur most frequently during the summer at Barter Island. The sun has migrated north and provides almost constant insolation. The Polar high pressure system dominates the area, even though it has weakened significantly from the winter months. This system brings maritime polar air into the region with an east to northeasterly flow. This type air mass in conjunction with a high pressure system generally results in the formation of an elevated subsidence inversion. In the Barter area, this inversion is normally intensified by the Arctic Ocean. This water body cools the air in the lower levels and adds significant moisture which causes stronger temperature and moisture gradients in the inversion. Depending on the actual gradient strength, superrefractive and trapping stratums generally form from approximately 2000 to 4000 feet.

SPRING AND AUTUMN

The transition periods at Barter Island have the highest frequency of normal refractive conditions. The sun is in its migratory mode which results in diurnal changes in insolation. Further, the dominant pressure systems of the summer and winter seasons are in periods of transition, thus, the primary causes of the abnormal refractive conditions during the winter and summer do not exist or are extremely weakened.

It should be noted that due to the interaction of maritime and continental air masses, the position and movement of the Arctic and Polar fronts and the changes in the dominant pressure systems, the atmosphere in the Barter Island area can be radical and erratic. Temporary temperature and moisture distributions can and do result in the formation of subrefractive, superrefractive, and trapping layers.

PROPAGATION CLIMATOLOGY

FOR

ARGENTIA, NEWFOUNDLAND

Prepared by

USAFETAC

The station at Argentia is located at an elevation of 51 feet above mean sea level on the western edge of the Avalon Peninsula. This peninsula composes the southeastern tip of Newfoundland. The terrain to the east and southeast of the station rises to a maximum elevation of 1075 feet above mean sea level. Relatively flat terrain is located south of the station. Placentia Bay lies along a line which runs from southwest to northeast of Argentia. The main landform of Newfoundland is located northwest of Argentia, across Placentia Bay. This landform consists of a plateau which rises in a northwesterly direction from the east coast. The west coast terrain of the island is composed of highlands.

Argentia's climate is determined both by its coastal location and by the prevailing pressure systems. Summer and winter temperatures are moderated by the influence of the cold Labrador Current, which virtually encircles Newfoundland. Argentia experiences a prevailing southerly wind year round. Argentia has a high frequency of fog from spring to late summer, which results from the

flow of warm air over the cold water of the Labrador current. Due to its coastal location, Argentia has mild year round temperatures. Argentia's coastal location also accounts for the frost-free period which ranges from 110 to 140 days per year. Argentia has abundant precipitation in the forms of rain and snow. Autumn and winter are the seasons which experience the heaviest amounts of precipitation. Beginning in autumn and stretching into spring, Argentia experiences the passage of a succession of traveling low pressure systems. As a result, the atmosphere is generally well mixed during this period. With the coming of the summer season, this storm track has moved north of Newfoundland. Consequently, fewer transient lows pass through this area during the summer months.

WINTER

Winter has a high frequency of normal refractive conditions. Some superrefractivity may occur, but little ducting is observed during the winter period. The frequency of occurrence of superrefractivity decreases toward the latter part of winter. February and early March experience the highest frequency of occurrence for normal refractive conditions. The high winter incidence of normal refractive conditions at Argentia is due to the passage of numerous transient low pressure systems during the winter. An even distribution of moisture with height is generally observed during the winter months as a result of these transient

lows. Overall, the latter part of the winter season yields the highest frequency of occurrence of normal refractive conditions.

SUMMER

During Argentia's short, mild, summer season, an appreciable increase in the frequency of occurrence of superrefractivity and ducting is observed. The relatively low incidence of normal refractive conditions which occurs in July and August is due to a combination of factors. Warm, summer air flowing over nearby cold bodies of water, rapidly picks up moisture. At the top of the moist layer an inversion may form.

The light winds experienced at Argentia during the summer season are generally not strong enough to break up this inversion. In this case, ducting or superrefractivity is likely to occur within the low level inversion layer. In an overall comparison with the remainder of the year, summer has the lowest frequency of occurrence of normal refractive conditions.

SPRING AND FALL

During the spring transition season, Argentia experiences refractive conditions similar to those that occur during the winter months. This is due to the fact that during most of the spring season, Argentia is dominated by the same general weather regime that is present during the winter season. While the frequency of occurrence of normal refractive conditions is

not as high in the fall as in the spring, refractive conditions generally are within the normal category. Argentia's transition seasons are periods during which normal refractive gradients are observed a majority of the time.

PROPAGATION CLIMATOLOGY
FOR
MELVILLE, LABRADOR, CN.

Prepared by
USAFETAC

Melville is located on the eastern shore of Goose Bay. Goose Bay airport is located across the bay and slightly northwest of Melville. To the northwest and north, an interior plateau rises to elevations of over 2000 feet. To the west-southwest of Goose Bay airport, this plateau ends at the Hamilton River Valley. The river valley is dotted with hills that reach elevations of 1500 feet. East and southeast of Melville, the Mealy Mountains rise sharply to a maximum elevation of 3700 feet. Northeast of Melville, Goose Bay empties into Lake Melville which in-turn empties into the Atlantic Ocean.

The climate of Melville is one of the best in Labrador due to the fact that air masses approaching from any direction except the northeast must subside. The subsiding air masses cause Melville and its vicinity to have higher average temperatures, less precipitation, and more sunshine than the surrounding uplands. The fog and cool temperatures which are common on the Labrador coast in summer rarely occur at Melville. Due to the extensive nearby areas of open water during the warmer months, maritime arctic is the predominating air mass in summer. Summer cumulus and stratocumulus cloud cover usually becomes broken to overcast during the day and only partially dissipates at night.

As a result, nighttime temperature inversions are fairly common during the summer months. Although Melville does experience the passage of some transient low pressure systems during the summer, the lows are not as frequent or as well developed as those which pass through Melville during the remainder of the year. Lows which pass to the south and east of Melville are common in all seasons of the year except the summer. Frequent low passages during fall, winter and spring result in a well mixed atmosphere during these seasons.

WINTER

Melville's highest observed frequency of normal refractive conditions occurs during the winter season. The turbulent mixing which occurs because of the presence of transient lows causes an even distribution of moisture with height, which in-turn usually produces refractive gradients which fall within the normal category. Consequently, very little ducting is observed and the frequency of superrefractive gradients remains relatively low throughout the winter months. Normal refractive conditions should be expected a majority of the time during the winter at Melville.

SUMMER

Relatively few low pressure systems pass through Melville during the summer months. Consequently, less turbulent mixing occurs during the summer than during

the winter and as a result, moisture can become stratified in the lower layers of the atmosphere. These factors account for the frequent occurrence of a maritime inversion at Melville during the summer months. Subrefractivity, superrefractivity, or trapping may occur within the inversion layer. If strong winds are present, this inversion layer breaks up. Although Melville's summer has the highest seasonal frequency of trapping and superrefractive gradients, normal refractive gradients occur a majority of the time.

SPRING AND FALL

Normal refractive conditions prevail throughout the transition seasons at Melville. As the fall season progresses, a decrease is observed in the already low occurrence of superrefractive gradients. Similarly, an increase is observed in the frequency of normal refractive gradients. This trend is reversed during the spring season. The observed frequency of superrefractive gradients increases from early to late spring while the observed frequency of normal refractive gradients decreases from early to late spring. The high incidence of normal refractive conditions during both the transition seasons is due to the the frequent passage of transient low pressure systems which thoroughly mixes the atmosphere and causes an even distribution of moisture with height.

PROPAGATION CLIMATOLOGY
FOR
CAPE PARRY N.W.T., CN.

Prepared by

USAFETAC

The site at Cape Parry is located well north of the Arctic Circle near latitude 70°10'N and longitude 124° 13'W, on the south shore of Admundsen Gulf. This gulf opens into the Arctic Ocean to the northwest of Cape Parry.

Several climatic controls interact to determine the climate at Cape Parry. Since Cape Parry is located north of the Arctic Circle, the sun is continuously below the horizon for a period during the winter. Even though no solar radiation is received during this period, the ground continues to radiate heat into space which can result in the formation of a very strong surface-based inversion. During the summer months when the Admundsen Gulf is relatively clear of ice, some maritime influences are exerted on Cape Parry's climate. Synoptic pressure patterns exert the strongest influence on Cape Parry's climate. During the winter season, a strong, stationary high pressure system is located just east of Cape Parry while high pressure also prevails over the frozen Arctic Ocean to the northwest of Cape Parry. Spring brings a gradual fall in pressure so that when summer arrives, pressure gradients over the entire Arctic Archipelago are very weak. This flat pressure pattern begins to disappear in early September when a gradual rise in pressure is observed.

WINTER

Winter has the lowest observed frequency of normal refractive gradients due to the influence of semi-permanent high pressure systems that are present during this season. Subsiding air, which accompanies the prevailing high pressure, may allow the atmosphere to become stratified in stable layers. When this stratification occurs, subrefractivity, superrefractivity, or trapping may occur within one or more of the stable layers. The light winds and frequent calms which occur due to the presence of the high pressure systems, are usually not sufficient to break up the stable layers through turbulent mixing. Consequently, the winter frequency of occurrence of superrefractive gradients, subrefractive gradients,and trapping gradients is high in relation to other seasons of the year.

SUMMER

The summer months have a slightly higher incidence of normal refractive gradients than the winter months. However, a significant amount of superrefractivity and ducting does occur due to the light summer winds and the maritime influence of the gulf. An inversion may form over the cold waters of Admundsen Gulf, and as a result, trapping or superrefractivity may occur within the inversion layer. Generally, summer winds are not strong enough to break up the inversion layer. During the period when the sun does not set, diurnal influences are absent and, consequently, maritime inversions may persist for long periods of time.

SPRING AND FALL

The transition seasons, especially fall, have higher frequencies of occurrence of normal refractive gradients than winter or summer. Spring is marked by a gradual fall in surface pressure which is accompanied by stronger winds than those which occur during the summer or winter. Consequently, more turbulent mixing occurs and the frequency of occurrence of refractive gradients which cause anomalous propagation is lowered.

The fall season has the highest observed seasonal frequency of normal refractive gradients. September and October have the highest frequency of normal refractive gradients of the fall months. The strong winds that occur during much of the fall season keep the atmosphere well mixed. Consequently, there is an even distribution of moisture with height which causes an increase in the frequency of occurrence of normal refractive gradients. The transition seasons, especially fall, experience a high frequency of normal refractive conditions.

PROPAGATION CLIMATOLOGY

FOR

CAMBRIDGE BAY, CANADA

Prepared by
USAFETAC

The station at Cambridge Bay is located in the Arctic Archipelago on the south coast of Victoria Island. Victoria Island is located just north of the Canadian Mainland. Cambridge Bay station is approximately 74 feet above mean sea level. Victoria Island stretches north of the station and is made up of barren terrain with elevations varying between 500 and 750 feet above mean sea level. Since Cambridge Bay is located at latitude 69° 06' N and Longitude 105° 08' W, it falls well within the Arctic Circle and thus experiences a period of time during the winter months when the sun does not rise above the horizon and a summer period when the sun does not sink below the horizon. Dease Strait is located southwest of the station, while Queen Maud Gulf is located to the southeast. Both of these bodies of water, and any surrounding inland channels or lakes, are completely frozen over by late October and remain frozen until the latter part of May or Early June when leads and cracks begin to appear in the ice.

Cambridge Bay's climate is determined by the interaction of several climatic controls. There is a winter period when no solar radiation is received during which

the ground continues to radiate heat. This enables a strong surface-based radiation inversion to form. During the winter, a strong stationary high pressure system is located over Cambridge Bay and the McKenzie Valley. Likewise, a strong low pressure system is oriented in a north-south direction over the Baffin Bay area. From January through March, the high pressure system above the McKenzie Valley and Cambridge Bay weakens while a new high pressure area forms and intensifies over Hudson Bay. By late April, high pressure covers the entire Arctic Archipelago. As August approaches, a rather flat pressure gradient covers the Archipelago. Pressure begins to rise with the advent of autumn so that by November, a strong well-defined high pressure system is again located over the Cambridge Bay area.

WINTER

A strong stationary anticyclone prevails over the Cambridge Bay area during November through March. As a result of the subsidence which accompanies this high pressure, an elevated inversion usually forms. Super-refractive conditions may occur within the inversion layer. If sufficient wind is present, turbulent mixing will take place and the inversion layer will be broken up. On the whole however, mean wind speeds in the Arctic are not as strong during the winter as in the fall. Light winds and calms are most frequent during winter and early spring. Consequently, subsidence caused by the winter high pressure system combined with light winds increases the probability of the atmosphere becoming stratified in stable layers. December has the lowest average monthly wind speed

and experiences the greatest frequency of superrefractive conditions. The frequency of occurrence of ducting in the winter months is fairly low.

SUMMER

Cambridge Bay experiences a modified maritime climate over the short summer season. During this period, a maritime inversion usually develops over the station at Cambridge Bay. This is caused by relatively warm, dry air passing over nearby cool bodies of water. Ducting and superrefractivity are common occurrences within the inversion layer. If moderate to strong winds are present, turbulent mixing may break up the inversion.

SPRING AND FALL

Late spring and late fall have the highest frequency of normal refractive conditions. May has the highest frequency of normal refractive conditions of the spring months. The fall month of October has the highest frequency of occurrence for normal refractive conditions. The generally strong winds which occur in October result in an even distribution of moisture with height. Generally then, the latter parts of the two transition seasons provide a fairly high frequency of normal refractive conditions.

PROPAGATION CLIMATOLOGY

FOR

HALL BEACH, N.W.T., CANADA

Prepared by

USAFETAC

The station at Hall Beach is located on the eastern edge of Melville Peninsula at an elevation of approximately 21 feet above mean sea level. The surrounding terrain is composed of barren hills, narrow lakes, and glacial drift. Hall Beach is located on the west side of Foxe Basin. The cold water from this basin flows southward and empties into Hudson Bay. The waters of Foxe Basin modify Hall Beach's climate during the warmer months of the year. However, Foxe Basin does not normally become completely free of ice even during the summer months and it is frozen over approximately eight months out of the year.

The climate at Hall Beach is controlled by several factors. The station is located well north of the Arctic Circle and hence receives no solar radiation during a portion of the winter season. During this winter period, the earth continues to undergo radiational cooling which enables a strong, persistent surface-based radiation inversion to form.

The climate at Hall Beach is also affected by the prevailing pressure system. During the winter months, the weather at Hall Beach is dominated by a general pattern of high pressure. The high pressure system is generally

accompanied by subsiding air and light winds which may cause a temperature inversion to form. With the beginning of spring, the stationary high pressure system begins to weaken. This weakening continues throughout the spring season so that by the time summer arrives, a rather flat pressure pattern prevails over the entire Arctic Archipelago. Pressure begins a gradual rising trend with the advent of autumn, reaching maximum sometime in late November or December.

The prevailing wind direction at Hall Beach is northwesterly. Some southeasterly winds are experienced during the summer when Foxe Basin is relatively free of ice. The strongest winds generally occur during the transition seasons with a maximum recorded during the fall months. Summer, and winter in particular, experience light winds and frequent calms.

As would be expected from its arctic location, Hall Beach is dominated by continental polar air during the majority of the year. This cold, dry air is modified somewhat during the summer months when moisture from nearby unfrozen bodies of water is added to this air mass.

WINTER

During the winter period, Hall Beach's climate is dominated by a high pressure system with accompanying continental polar air. The resultant subsiding air and light winds enable a strong temperature inversion to form at or slightly above the surface. Superrefractive conditions are likely to occur within the inversion layer. Calms and light winds prevail at Hall Beach during the winter so that little turbulent mixing of the atmosphere

occurs. As a result, the temperature inversion is persistent and the atmosphere can become stratified in stable layers. Superrefractive gradients are likely to occur within one or more of these stable layers. The winter season experiences the highest frequency of occurrence of superrefractive conditions. Of the winter months, January experiences the highest frequency of superrefractive gradients. The incidence of ducting is relatively low during the winter months.

SUMMER

Due to its location north of the Arctic Circle, Hall Beach has an abbreviated summer season. Late June, July, and August generally comprise the summer season at Hall Beach. During this period of the year, Hall Beach experiences a modified maritime climate. Warm, dry air passing over cold bodies of water nearby result in the formation of a low level maritime inversion. Superrefractive gradients may occur within the inversion layer. If strong winds are present, turbulent mixing can occur and break the inversion.

SPRING AND FALL

Spring and fall have the highest frequency of occurrence of normal refractive conditions. May has the highest frequency of normal refractive conditions of the spring months. September has the highest frequency of occurrence for normal refractive conditions. The transition seasons generally experience moderate to strong winds which cause an even distribution of moisture with height. Turbulent mixing and the even moisture distribution with height combine to create atmospheric conditions

which give the transition seasons at Hall Beach a high frequency of occurrence of normal refractive gradients.

PROPAGATION CLIMATOLOGY
FOR
CAPE DYER, N.W.T., CANADA

Prepared by

USAFETAC

Cape Dyer is located at 66°nn'N latitude 61°37'W longitude on that portion of Baffin Island known as the Cumberland Peninsula. No upper-air observations are available for Cape Dyer or for any location in the vicinity whose data would be applicable to Cape Dyer. Due to this lack of upper-air data, no refractive index information is available; therefore, this narrative will be based on known climatological factors and the resultant propagation effects based on generally accepted refractive propagation theories.

The climate of Baffin Island is remarkably uniform and wholly arctic. Those variations that do exist result from local topography. Cape Dyer lies on the southeast shore of Cumberland Peninsula on the west side of the Davis Straits. This portion of Baffin Island is marked by its uneven, mountainous terrain and the many fiords that penetrate the interior highlands. Due to these topographic features, notable differences in climate exist because of variable exposure to wind and sun. The amount of incoming solar radiation and the close proximity of Baffin Bay are the main influences on the climate at Cape Dyer.

WINTER

During the winter months, the sun remains below the horizon much of the time, allowing very little insolation in the Cape Dyer area. This area lies on the western flank of the intense Icelandic Low which brings in cold dry air with a prevailing northerly flow. This advection of cold air coupled with lack of insolation and increased surface radiation provides Cape Dyer with a pronounced continental polar climate. Continental polar air generally indicates low surface temperatures and moisture content and is marked by the presence of a surface-based radiation inversion. This inversion extends to heights of three to eight thousand feet and can cause occurrences of abnormal refractive conditions. However, in the Cape Dyer region, two factors modify this inversion and greatly reduce its effect on refractivity; the water of Baffin Bay and transient low pressure systems. Baffin Bay, although almost completely frozen during the winter months, modifies the low level temperatures through radiation and reduces the temperature gradient thru the inversion. Migratory low pressure systems approach Baffin Bay from the south very frequently during the winter months. These systems occasionally bring warmer air into the area which again reduces the temperature gradient. However, very little moisture is available in the atmosphere due to the colder temperature and lack of a moisture source and what moisture that does exist is thoroughly mixed by the predominence of the low pressure.

SPRING

Meteorological conditions change quite abruptly during

the spring season. High pressure dominates the area from March through May and the number of migratory low pressure systems decreases. These phenomena present favorable conditions for stratification of stable layers aloft in the atmosphere. These layers (inversions) can result in the existence of superrefractive or trapping stratums during this period however, the frequency and intensity of those inversions that do form should have little effect on propagation.

SUMMER

The summer season at Cape Dyer is relatively short and mild. Although Baffin Bay is partially thawed, the water is filled with melting ice which aids in modifying the climate. Further, although the sun remains above the horizon much of the time, the angle is such that the amount of insolation is minimal. The summer season is dominated by low pressure with the pressure center in the area of Hudson Strait. A trough extends northeastward across Baffin Island to include the Cape Dyer area. A marked increase in the frequency of migratory low pressure systems is seen entering the area from the west. During the summer the air mass is of the maritime variety, which is typically moist and rather unstable. Over the sea and along onshore coasts there often exists a shallow inversion or stable layer just above the unstable air at the surface. This inversion,with its radical temperature and moisture gradients,can cause abnormal refractive conditions.

AUTUMN

Autumn is a very brief season of transition with conditions changing rapidly to those that prevail during

the winter. During this period low pressure dominates; however, the track of migratory systems begins their transition from west to south. This period from late September through October has the highest frequency of normal refractivity.

Although possible causes for abnormal refractive conditions have been presented here, atmospheric conditions in the Cape Dyer area are such that the frequency of these conditions would be quite small. The prevalence of low pressure and the mixing that accompanies this plus the lack of moisture throughout the year indicates that normal refractive propagation conditions should prevail with minor variations with the seasons.

PROPAGATION CLIMATOLOGY
FOR
THULE, GREENLAND

Prepared by
USAFETAC

Thule is located on the west coast of Greenland about 600 miles north of the Arctic circle. To the east is the Greenland ice cap which rises to an elevation of 10,000 feet in the interior. Baffin Bay, which extends from north through west through south, connects with the Atlantic Ocean through the Davis Straits. The prevailing pressure patterns affecting the Thule area are the Icelandic Low, a weak high pressure system over the ice cap, and an inverted trough over the Davis Straits.

The climate at Thule is divided into two main seasons, winter and summer, with short transitional periods between. Refractive conditions remain relatively unchanged throughout the year with normal gradients prevailing in all months. Summaries of refractive conditions do reflect some deterioration in late winter and midsummer and depict the short transition periods as enjoying the most normal conditions.

WINTER

During the winter season, the Icelandic low and the high pressure system over the ice cap alternately dominate the Thule area. These pressure systems bring cold, dry polar continental air to Thule off the interior ice cap.

This cold air advection coupled with surface radiational losses, causes the surface layers to become very cold. The result is the formation of a radiation type inversion. Two items tend to nullify the effect of this inversion on refractive propagation conditions; Baffin Bay and strong winds. Baffin Bay, although frozen during the winter, exerts a modifying influence on the cold polar continental air mass and reduces the temperature lapse rate through the inversion. Strong winds, resulting from pressure gradients over the ice cap and transitory low pressure systems, mix the atmosphere and minimize the moisture gradient.

SUMMER

Thule is subject to almost continuous insolation during the summer months of May through August. With Baffin Bay void of ice, and with prevailing westerly winds, Thule experiences a modified maritime climate. This relatively warm, moist air in the lower layers gives way to colder,drier air aloft. This slight temperature gradient and, more importantly, the moisture gradient is ideal for the formation of superrefractive and trapping stratums. Diurnal variance and local topographical features cause ephemeral changes that can affect refractive propagation conditions.

SPRING AND AUTUMN

The transition seasons at Thule are very short as the amount of insolation, the predominate pressure systems, and the prevailing winds are in a state of change. These factors result in the persistence of normal refractive propagation conditions.

PROPAGATION CLIMATOLOGY

FOR

DYE-3 (ICE CAP STE-2), GREENLAND

Prepared by

USAFETAC

Dye-3 (Ice Cap STE-2), Greenland, is located at 65° 11' N latitude, 043° 50' W longitude on the ice cap of southern Greenland. The elevation of Dye-3 is approximately 8000 feet. The surrounding area is ice and snow covered throughout the year.

The dominant pressure systems in the Dye-3 area are the semi-permanent high over the ice cap and the Icelandic low centered just south of Greenland. Continental polar air dominates the area throughout the year with only slight ephemeral modifications.

No upper air observations are taken at Dye-3 nor at any other location in the immediate area. Due to the geographical separation of Dye-3 from active upper-air stations in Greenland and the corresponding topographical differences, their climatological data cannot be directly applied to Dye-3. Therefore, this narrative will be based on regional weather phenomena, assumed and known local effects, and generally accepted refractivity theories.

The summer and winter seasons at Dye-3 are both relatively long with spring and fall being short transition periods. The seasons are determined by the migration of the sun and the resultant amount of insolation received

at the surface. Refractive conditions should remain fairly constant throughout the year, with normal refractivity being the prevalent condition.

WINTER

The winter months are marked by a reduction in insolation to the point where, from approximately November through January, the sun remains below the horizon and no insolation is received. This lack/loss of insolation, coupled with surface cooling caused by evaporation, produces a surface based radiation inversion with a very strong temperature gradient. This inversion can cause subrefractive, superrefractive, and trapping conditions to exist based on the moisture gradient through the inversion and the thickness of the inversion. As at most northern, high elevation locations, the temperatures are so cold that little moisture is available in the atmosphere. This fact implies that the thickness of the inversion is the determining factor as to the abnormal conditions. This thickness and intensity is also a function of wind speed and turbulence. Low wind speeds allow the temperature inversion to become intense and higher wind speeds tend to bring relatively warmer air from aloft to the surface, thereby destroying or weakening the inversion. The existence of the intense Icelandic low during the winter months causes stronger winds and helps minimize the effect of the inversion.

SUMMER

The summer months are marked by an increase in the amount of insolation as the sun migrates north. From approximately April through July, the sun remains almost

constantly above the horizon. However, due to the northern latitude of the Greenland area, the angle of the sun's rays decreases the intensity of the insolation. This insolation does break the surface inversion of the winter period and results in temperature and moisture gradients which can be slightly subrefractive. The refractive conditions during the daily period of maximum insolation will be somewhat variable because of convective eddies and currents caused by diurnal temperature changes. However, during the daily periods of low insolation these phenomena do not exist and refractivity will be less variable. It is in the evening and early morning hours that superrefractivity and trapping may occur.

SPRING AND FALL

The transition seasons in the northern latitudes are very short and usually experience the highest incidence of normal refractive conditions. This is due primarily to the fact that those phenomena that can cause abnormal conditions during the winter and summer are also in a state of transition and have little to no effect on refractive propagation.

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